Artificial phospholipids have attracted much attention in biochemistry, materials science, and synthetic chemistry. In particular, self-assembling ability of artificial phospholipids is utilized for the preparation of giant vesicles and liposomes to be applied as templates of inorganic materials. The present study was focused on novel-type phospholipids \( L_1 \) and \( L_2 \), having an electro- and/or light-responsive calamitic mesogenic core.\(^{[1]}\) Introduction of such properties into artificial phospholipids is expected to result in the development of electro- and light-responsive lipid bilayer membranes and thin films, in other words active membranes.

Phase behavior and structure of \( L_1 \) and \( L_2 \) in water were determined by polarized optical microscopy using a high pressure hot stage to prevent water evaporation, differential scanning calorimetry, and small angle X-ray scattering (SAXS). The \( \text{H}_2\text{O}/L_1b \) system shows a lyotropic rectangular columnar (Colr) phase at lower temperatures and a smectic A (SA) phase at higher temperature. The Colr-SA and SA-Isotropic phase transition temperatures decrease with increasing \( \text{H}_2\text{O}/L_1b \) ratio. Similar phase behavior was found in the \( \text{H}_2\text{O}/L_1a = 0.25-1.0 \) systems, and both Colr and SA phases were observed. However, in the \( \text{H}_2\text{O}/L_1a = 1.5 \) system, schlieren texture with low viscosity was formed in the temperature range to 213 °C. This texture was characteristic of a nematic (N) phase. Regarding the \( \text{H}_2\text{O}/L_2b \) system, both oily streak and schlieren textures, characteristic of a lyotropic smectic C (SC) phase, are found at temperatures below those of the SA phase. Thus, lyotropic LC self-assembly is strongly influenced by the calamitic mesogenic core. The SAXS pattern of this sample recorded at 40 °C indicated the presence of a rectangular columnar phase, plane group \( p2gg \). The Colr reconstructed electron density map is shown in Fig. 1b, and the molecular self-assembly of \( L_1b \) in elliptical columns is shown in Fig. 1c. A similar \( p2gg \) Colr phase was also observed in the \( \text{H}_2\text{O}/L_1a = 1 \) and \( \text{H}_2\text{O}/L_1b = 1 \) systems.

We have studied the electric response of lyotropic LC systems of \( L_1a \). After applying the voltage, strong birefringence was found. Before the application, the alignment was homeotropic. The birefringence is attributed to molecular and/or orientation tilt resulting from the interaction of the field with \( L_1a \). Such electric response is also observed in the N phase of \( \text{H}_2\text{O}/L_1a = 1.5 \). To the best of our knowledge, this is the first report on the orientation control of lyotropic LCs having phospholipid bilayer structures by electric field. Introduction of dynamic functions into artificial phospholipids is expected to result in the development of electro- and light-responsive lipid bilayer membranes controlling ion and/or material transport.